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## Integrating biologically rational strategies for control of anthracnose fruit rot of strawberries

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**Lead Investigators**

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## Integrating biologically rational strategies for control of anthracnose fruit rot of strawberries

**Abstract:** Anthracnose poses a serious threat to Iowa's strawberry harvest. Several biologically friendly strategies were tested for their effectiveness in controlling anthracnose and positive impacts on yields.

### Background

Anthracnose fruit rot appeared in Iowa less than a decade ago but has become a major threat to commercial strawberries in the state. Anthracnose, caused by the fungus *Colletotrichum acutatum*, can cause 100 percent loss of a strawberry crop. Day-neutral strawberries, an increasingly popular choice of Iowa strawberry growers, are exceedingly vulnerable to anthracnose. Conventional fungicides used against anthracnose are only partially effective and may soon face added restrictions from the Environmental Protection Agency (EPA). New, environmentally friendly tactics are urgently needed to control this emerging disease problem.

### Approach and methods

One major goal was to isolate native microorganisms from the strawberry leaves and select from them the most promising biological control agents for use against strawberry anthracnose. Project investigators isolated 207 microorganisms and visually assessed their ability to inhibit growth of *C. acutatum* on agar media. The most effective of these candidate isolates (five fungal isolates and six bacterial isolates) were identified and characterized. The isolates were then evaluated for control of populations of anthracnose fungus on clean and biocontrol-treated leaves.

Investigators tested the effectiveness of a new fungal biocontrol agent (*Trichoderma*

*harzianum*, trade name T-22) and two plant-defense inducing compounds (harpin, trade name Messenger, and salicylate, trade name ActiGuard) for control of strawberry anthracnose. Project workers also tested the ability of straw mulch to reduce the spread of anthracnose in day-neutral strawberries.

### Results and discussion

Of the 11 most effective native microorganisms selected from the strawberry leaves for use against strawberry anthracnose, there were one bacterial and five fungal isolates that substantially reduced reproduction of *C. acutatum* on leaves. These naturally occurring microorganisms are promising candidates for development of a biological control agent against strawberry anthracnose.

Neither the new fungal biocontrol agent nor the plant-defense inducing compounds reduced the symptoms of anthracnose on day-neutral (Tristar) strawberries in our field trials, nor did they increase yield in any of the three years of trials. However, a "reduced-risk" strobilurin fungicide, Abound, effectively controlled anthracnose in 1998, 1999, and 2000 on day-neutral berries. Disease development in June-bearing (Honeoye) strawberry plots was not sufficient to measure the effect of the biological controls in either 1999 or 2000.

Plots where straw mulch was used showed a consistent reduction in the incidence of anthracnose on fruit. They also had increased yields during the 1999 and 2000 seasons. When mulching was combined with applications of

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### Budget:

\$14,278 for year one  
\$14,115 for year two  
\$17,700 for year three

**Question:** How can control of anthracnose fruit rot be improved and made more sustainable? **Answer:** Using straw mulch and a reduced-risk fungicide will provide more effective and sustainable disease control.

**Diseased fruit**



Abound, a level of control above that of conventionally sprayed plots was achieved. An economic analysis of this Integrated Pest Management (IPM) approach shows that it could save a grower \$518 per season in chemical costs, reduce the quantities of highly toxic chemicals used, and increase yield by up to 60 percent in years of high disease pressure.

## Conclusions

This project tested the effectiveness of several biological and cultural weapons against anthracnose on June-bearing and day-neutral strawberries. After screening scores of naturally occurring microbes from Iowa strawberry plants in laboratory tests, it appeared that several fungi and bacteria limited growth of *C. acutatum* on strawberry leaves. This project succeeded in setting the stage for evaluating these promising microbes in the field.

Investigators also field-tested several biological-control products that are either commercially available or nearing EPA registration, including T-22 (a formulation of the biocontrol fungus *Trichoderma harzianum*) and ActiGuard and Messenger, two compounds that stimulate the plant's own disease defenses. None of these products gave significant control of anthracnose fruit rot. On the other hand, a new fungicide called Abound, which EPA

rates as having low risk of environmental harm, offered anthracnose control equivalent to conventional fungicides.

In a 2000 field trial, researchers found that a combination of straw mulch and plastic between rows succeeded in slowing the spread of anthracnose in day-neutral strawberries and reducing the incidence of diseased berries. Mulching combined with Abound also was found to be effective. An analysis of the profitability of the successful alternative disease-control tactics is ongoing.

The project yielded important new insights into the anthracnose life story. Laboratory, greenhouse, and field experiments showed that *C. acutatum* can survive and even multiply on healthy-looking strawberry leaves. This behavior is invisible to the naked eye, but may set the stage for sudden, massive anthracnose outbreaks once ripening fruit appear in the field. This work suggests that it may be possible to stop an anthracnose outbreak by targeting the early part of the growing season, before fruit appear.

## Impact of results

The most important scientific benefit of this project was the increased understanding of the ecology of *C. acutatum* on strawberry leaves that have yet to show symptoms of anthracnose. Techniques are needed to recognize anthracnose spores before lesions develop. An ISU doctoral student working with the project discovered that *C. acutatum* (spores) are able to germinate from existing conidia on strawberry leaves without causing visible disease symptoms. The finding exposed a previously unknown source of inoculum and adds a new stage to the disease cycle of *C. acutatum* on strawberry. The student has gone on to determine the effects of weather and fruiting on this condition and her results will have a major impact on future management studies.

The project evaluated the effectiveness of several biocontrol strategies that may be useful to growers. The trials with commercial biocontrol organisms showed them to be inconsistent and less than effective in reducing disease. Abound, a reduced-risk fungicide, was shown to help reduce disease and help increase yields, especially when used in conjunction with straw mulch. However, this product is not authorized for use in organic production systems, so other biocontrol organisms need to be found and tested under field conditions.

Straw mulch reduced the incidence of anthracnose on harvested fruit by 53 percent and increased yield by 62 percent in project trials. This strategy could provide farmers with significant increases in profitability.

## Education and outreach

Iowa's 200 commercial strawberry growers were updated about the project via newsletter articles, field days at the ISU Horticulture Farm, WOI-AM radio tapes, and press releases. Presentations at annual meetings of the Iowa Fruit and Vegetable Growers Association summarized the most successful non-chemical tactics uncovered in the study and the take-home messages about the project for growers.

Scholarly papers about the project appeared in *Biological and Cultural Tests for Control of Plant Diseases*, *Phytopathology*, and *Advances in Strawberry Research*.

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